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Abstract

In spite of the wide usage of globally dispersed virtual teams (VT), there has been relatively little research on how leadership affects team performance, particularly with new product development teams in a global VT setting. A research model of VT leadership was developed and evaluated with a confirmatory factor analysis and structural equation modeling for a unique sample of 19 globally dispersed VTs and 25 nationally dispersed VTs in a variety of industries. Results showed that less geographically dispersed VT members have shown higher team performance only when leadership roles were performed effectively. In addition, leadership role effectiveness fully mediated the relationship between the number of team training sessions and team performance. Recommendations for academic researchers and practical implications were suggested.

Keywords: virtual team leadership; geographically distributed teams; virtual team training; leadership roles

Advancements in technology have supported the trend toward geographically dispersed work groups collaborating through technology (Algesheimer, Dholakia, & Gurău, 2011). Many organizations are increasingly adopting virtual teams (VTs) to solve challenging problems by connecting worldwide experts. However, dispersed teams may face difficulties; lacking face-to-face interactions in VTs may negatively influence social processes, creative solutions, trust, and collaborative effectiveness (Han, Chae, Macko, Park, & Beyerlein, 2017; Hertel, Geister, & Konradt, 2005; Hinds & Mortensen, 2005). Therefore, understanding the characteristics of VTs and leadership roles has emerged as a new area of inquiry to enhance social and task team processes. Below are several reasons that necessitate the current study in the global VT research area.

First, a few scholars have examined team leadership with an emphasis on VTs (Barnwell, Nedrick, Rudolph, Sesay, & Wellen, 2014; Brake, 2006; Kayworth & Leidner, 2002). However, there is relatively little research on how different leadership roles affect VT interaction and performance (Carter, Seely, Dagosta, DeChurch, & Zaccaro, 2015; Kayworth & Leidner, 2002). Some laboratory studies examined how different leadership styles (e.g., transactional, transformational, participative, and directive styles) may enhance performance in computer-mediated teams (Hambley, O'Neill, & Kline, 2007; Kahai & Avolio, 2006; Kahai, Sosik, & Avolio, 2003). A small number of field studies also exist on VT leadership (Davis & Bryant, 2003; Hoch & Kozlowski, 2014).

Second, the literature on VTs is growing (Han & Beyerlein, 2016); few studies, however, have provided a comprehensive understanding of the effects of team members' global and national dispersion on VT performance. Although many scholars have studied the effectiveness of face-to-face teams with culturally diverse groups for more than a decade (Vodosek, 2007; Winkler & Bouncken, 2011), fewer have empirically studied multinational team processes and performance in a VT setting.

Third, this study seeks to fill a gap in the VT leadership literature by exploring the mediation effect of leadership role effectiveness between VT characteristics and performance. While past research on leadership in VTs focused on the impact of communication on team performance and members' satisfaction (Maznevski & Chudoba, 2000), leadership roles have received relatively little attention in empirical studies. Most VT leadership empirical research is laboratory-based with student groups (Kayworth & Leidner, 2002; Martins, Gilson, & Maynard, 2004; Zigurs & Kozar, 1994) and cannot capture the complexity of VT dynamics, so more field research on various leadership roles and effectiveness within VTs is needed.

Therefore, the purpose of the field-based study is to examine the relationships among team input characteristics, leadership role effectiveness, and team performance in VTs. This study investigated whether VT leadership role effectiveness mediates the relationship between team input characteristics (global dispersion and team training) and a team output variable (team performance). Then, the proposed research model was evaluated with a confirmatory factor analysis and structural equation modeling. The first research question asked the associations among global dispersion of the team, team training, leadership role effectiveness, and team performance. The second research question asked leadership role effectiveness mediates the relationship between global dispersion of the team/training and team performance.

Theoretical Background and Hypothesis Development

Both global virtual teams and national virtual teams were examined in this current study. The terms distributed, dispersed, and virtual teams have been used interchangeably in the literature. Cramton (2001) defined dispersed teams as people with a common purpose, grouped together, who work interdependently across time zones and locations and communicate via technology. This current study has followed Maznevski and Chudoba's (2000) definition of global virtual teams as being comprised of members who work and live in different countries and of national virtual teams as being comprised of members geographically dispersed in the same nation with similar cultural settings.

Our model was framed within the perspective of the input-mediator-outcome (IMOI) model (Ilgen, Hollenbeck, Johnson, & Jundt, 2005) to illustrate the pattern of emergent team processes and to display the simplified structural relationships. Team performance was included as a key output. This study examined the dynamics of VT input variables (global dispersion and team training) and a mediator (leadership role effectiveness). In the next section, each component of the team model was described before developing hypotheses.

Virtual Team-level Input Variables

Team inputs can be further grouped into three categories (McGrath, 1984): individual-level factors (e.g., personalities, competencies), team-level factors (e.g., task structure), and organizational and contextual level factors (e.g., environmental complexity). The main team-level inputs for this study are based on group-level factors that show team characteristics, such as team members' global dispersion, and team-training frequency.

Global Dispersion

Team members' global dispersion and the number of working sites represent geographic dispersion in teams. Global dispersion measures how far apart team members work nationally or globally. Although interdependent, team members from two or more collocated subgroups comprise a team and are more likely to reside in different countries (Duarte & Snyder, 2001; Muethel, Gehrlein, & Hoegl, 2012).

A team can be more dispersed when team members work at more sites if all other conditions are the same (O'Leary & Cummings, 2002).

Team Training

Global VT designs influenced the way organizational leaders and team members build relationships. Due to differences in leaders' management styles in a virtual setting, team training may be necessary. We define team training as a set of strategies designed to improve interpersonal relations and social interactions. Typically, these team trainings are designed to improve processes, such as meeting goals, accomplishing tasks, and addressing problems (Klein, DiazGranados, Salas, Le, Burke, Lyons, & Goodwin, 2009).

Team Processes: Leadership Roles

A number of prior studies have identified leadership roles as the most important team process factor that can influence VT performance both directly and through mediation between the team's characteristics and performance (Bell & Kozlowski, 2002; Kayworth & Leidner, 2002; Yoo & Alavi, 2004). Several researchers suggested different concepts to describe the classification of leadership roles and behaviors (McGrath, 1984; Quinn, 1988). As part of the Competing Values Framework, Quinn (1988) proposed the Behavioral Complexity in Leadership Theory to explain how group effectiveness depends on the breadth of the role repertory of the leader. Leaders who respond to varied situations from a variety of roles seemed to stimulate higher performance levels. We adapted Quinn's (1988) Competing Values Framework to the study of virtual teams as it recognizes the internal and external organizational demands on leadership role effectiveness. The framework also recognizes the paradoxical demands for both flexibility and control.

Eight leadership roles are categorized within the Competing Values Framework: the dimension of focus (internal vs. external) and leaders' attitude (flexibility vs. control). According to Quinn's (1988) work, the Task Leadership quadrant is characterized by a leader's controlling attitude, external focus and emphasizes setting and attaining goals. The Stability Leadership quadrant is characterized by a leader's controlling attitude, a focus on the team's internal function and emphasizes monitoring and coordinating teamwork. The People Leadership quadrant is characterized by a leader's flexible attitude, an internal focus and emphasizes mentoring subordinates and facilitating group process. The Adaptive Leadership quadrant is characterized by a flexible orientation, a focus on the external environment and emphasizes developing innovations and obtaining resources for the team. In this study, these dimensions were used to formulate the hypotheses in a VT.

Team Performance

The input-mediator-outcome framework has inputs, such as team composition or resources, which shape teamwork processes and then lead to outputs, such as team performance. This The framework can explain the mediation effects on the relationship between input and output variables (Ilgen et al., 2005). Previous studies have operationalized team output through a multitude of performance measures that can be classified into three main categories (Mathieu, Maynard, Rapp, & Gilson, 2008): (a) organizational-level performance, (b) team performance behavior and outcomes, and (c) role-based performance. In this article, team performance is considered the final outcome of team processes, having a subjective (expected performance) evaluation from team members.

Hypotheses

VT literature reveals inconsistent effects of national diversity across different contexts (Shachaf, 2008). The empirical study conducted on VTs found that globally dispersed teams increased the team effectiveness due to members' different perspectives and less groupthink (Shachaf, 2008). However, others found negative outcomes of nationally heterogeneous teams, which demonstrated a lower level of social integration and ineffective communication (Fain & Kline, 2013; Stahl, Maznevski, Voigt, & Jonsen, 2010). Globally dispersed teams may face conflicts and barriers to team performance due to differences in language, cultural norms, values, and working styles (Pinjani & Palvia, 2013). People typically interpret information based on their cultural values and biases, which leads to misinterpretations and unhealthy stereotypes; these are difficult to correct in VTs because of lack of face-to-face and informal interaction (Au & Marks, 2012; Pauleen, 2003).

In the current study, effectiveness of eight leadership roles were examined as theoretically-based mediators that affect the relationships between team input characteristics and team performance (Denison et al., 1995; Kayworth & Leidner, 2002). The eight leadership roles may affect performance differently in VTs than in face-to-face teams. Effective VT leaders demonstrate the capability to deal with issues by performing multiple leadership roles simultaneously (Kayworth & Leidner, 2002). For example, Kayworth and Leidner found that global VT leaders demonstrate various leadership roles by asserting their authority without being perceived as inflexible; articulate team members' role responsibilities effectively; provide regular, detailed, and prompt communication with their peers; act as a mentor; and exhibit a high degree of empathy.

Existing research indicates that successful leadership behaviors (House, Hanges, Javidan, Dorfman, & Gupta, 2004) and preferred leadership roles (House, Javidan, Hanges, & Dorfman, 2002) differ within various national cultures. For example, individualistic cultures that value achievement tend to be more motivated by a producer role in regard to

reward-based exchanges, and collectivist cultures prefer a directive to a participatory role (House et al., 2002). Globally dispersed VTs have been reported as having higher levels of creativity compared to national VTs (Shachaf, 2008; Stahl, et al., 2010). Leaders may help geographically dispersed teams utilize different expertise and enhance the overall effectiveness of their operations (Joshi, Lazarova, & Liao, 2009). One study also noted that leadership was rated higher in teams that were dispersed across two or more locations (Charlier, Stewart, Greco, & Reeves, 2016). The study suggested that leadership role effectiveness in terms of team performance can depend on a team's global dispersion. Therefore, we hypothesize that:

H1a: A higher degree of global dispersion in a team will relate to higher levels of team performance.

H1b: Leadership role effectiveness will mediate the relationship between a degree of global dispersion and team performance.

There are many effective training and development programs that target the necessary skills in face-to-face settings, but few studies explored their utility in electronically mediated teams. There are studies that show positive aspects of VT training effectiveness. For example, VT communication training led to increases in cohesiveness and satisfaction with processes over time and improved performance (Warkentin & Beranek, 1999). VT training was highly related to performance when teams had high levels of trust and technological support (Kirkman, Rosen, Tesluk, & Gibson, 2004). VT training is considered extremely valuable for future VT activities, particularly the following leadership skills: leading a meeting, mentoring, monitoring, and evaluating (Rosen, Furst, & Blackburn, 2006). These skills differ somewhat between virtual and face-to-face settings. Training proficiency positively related to performance when VT leaders had longer tenures, which can eventually lead to leadership role effectiveness (Kirkman et al., 2004). Specifically, scholars found that the effects of team self-guided training on conflict management were positive for virtual teams (Martínez-Moreno, Zornoza, Orengo, & Thompson, 2015). Based on such an understanding, we hypothesize that:

H2a: Attending a higher number of team training sessions will relate to higher levels of team performance.

H2b: Leadership role effectiveness will mediate the relationship between team training and team performance.

We have controlled team members' locations, team size, and team tenure followed by previous study practices (Gibson & Gibbs, 2006; Wiersema & Bantel, 1992). The reasons for controlling these variables are listed as follows. First, a larger number of sites in a team can bring more coordination complexity that results in lower work effectiveness compared to working in one location (Armstrong & Cole, 2002; O'Leary & Cummings, 2002). Scholars also found that individuals who are located in a same place, rated each other higher in leadership than individuals who are not co-located (Charlier et al., 2016). Second, studies also found that the big team size can decrease the amount of communication occurring within a team and reduce team cohesion (Armstrong & Cole, 2002; Bradner, Mark, & Hertel; Bennett & Kane, 2014). Third, for team tenure, team members with high tenure often learn how to get along and communicate with each other, which leads to positive outcomes (Beckman, 2006; Eisenhardt & Schoonhoven, 1990; Pinjani & Palvia, 2013; Sine, Mitsuhashi, & Kirsch, 2006). The positive effect of team tenure on performance has been attributed to effective leadership roles and skills, such as replicating routines, procedures, and norms that provide useful structure for coordinated action (Sine et al., 2006).

To this end, the conceptual model illustrates the hypotheses and relationships among factors in the Figure 1.

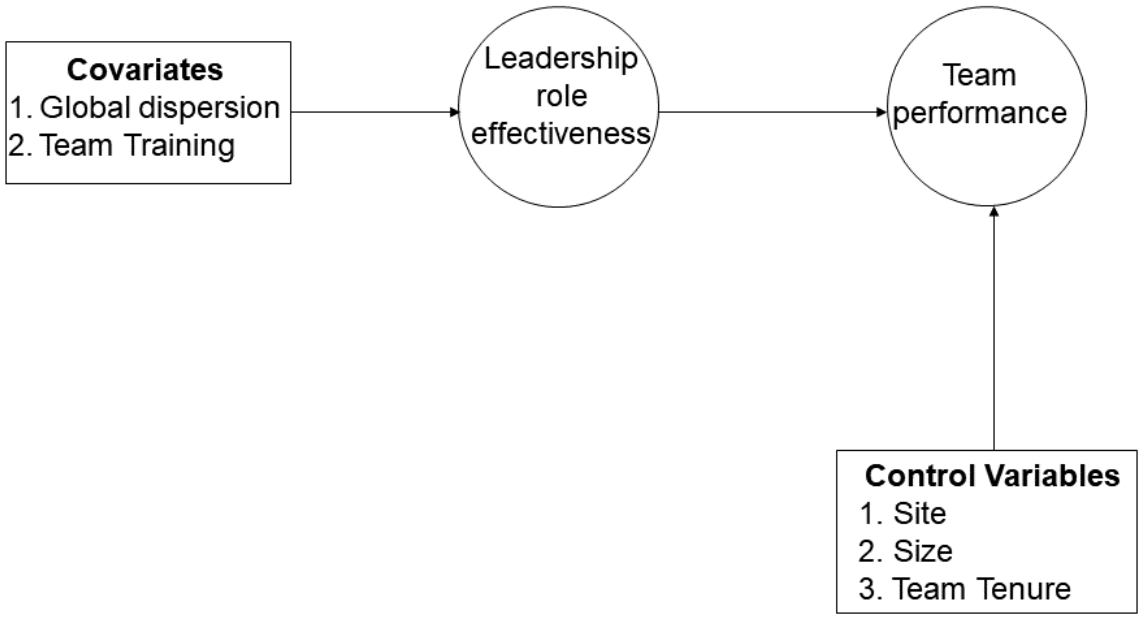

Figure 1. Theoretical model: Effects of covariates on team performance mediated by leadership role effectiveness

Methods

In this section, characteristics of participants and what and how we collected data were described.

Participants

The population for this study were new product development VTs in a variety of industries, including pharmaceuticals, financial services, consumer services, hospitality and leisure, manufacturing, insurance, professional services, telecommunications, technology, and non-profits. Participants' responses were collected through a questionnaire at 16 organizations. These organizations were enlisted through both previous professional contacts of one co-author and responses from newsletters. Initial contact was established with 48 teams representing 516 team members. Of these, 426 team members responded. However, we excluded some participants because their answers were not sufficiently complete. If all members' VT site was not certain or participants did not answer more than half of leadership-related items, their answers were considered insufficient and excluded. Finally, the analysis used 294 team members among 44 VTs.

A total of 24 countries were represented in the locations. Working places of 159 participants in 24 VTs were entirely within the United States. The average number of the sites in each team was 4.14. The average team size and team tenure were 13.41 and 2.54 years, respectively. Table 1 shows bivariate correlations, sample means, and standard deviation of all variables used in this study.

Table 1

Correlations, Means, and Standard Deviations of Variables

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1. GD	-																								
2. Site	-.06	-																							
3. Size	.31**	-.21**	-																						
4. Tenure	.09	.03	.05	-																					
5. Training	.06	-.06	-.05	.11	-																				
6. Perform1	.03	-.22**	0.00	.01	.13*	-																			
7. Perform2	-.07	-.18**	-.20**	-.01	.14*	.65**	-																		
8. Perform3	-.06	-.18**	-.03	-.02	.14*	.39**	.52**	-																	
9. Perform4	.03	-.24**	-.01	-.02	.06	.53**	.46**	.36**	-																
10. Broker1	-.15**	-.10	-.06	0.00	.24**	.36**	.37**	.40**	.36**	-															
11. Broker2	-.13*	-.07	-.04	.03	.25**	.33**	.38**	.37**	.39**	.68**	-														
12. FT1	-.11	-.03	.02	.02	.27**	.29**	.37**	.44**	.35**	.63**	.62**	-													
13. FT2	-.16**	-.05	-.07	.05	.32**	.28**	.40**	.37**	.30**	.59**	.69**	.66**	-												
14.Producer1	-.08	-.01	.03	.03	.23**	.32**	.33**	.43**	.37**	.62**	.65**	.72**	.60**	-											
15.Producer2	-.05	-.08	-.03	.08	.31**	.42**	.46**	.41**	.39**	.63**	.71**	.67**	.71**	.69**	-										
16. Director1	-.11	-.03	.09	.05	.30**	.35**	.37**	.38**	.31**	.63**	.69**	.61**	.69**	.71**	.69**	-									
17. Director2	-.07	-.05	-.11	.07	.28**	.43**	.49**	.43**	.36**	.57**	.65**	.64**	.65**	.60**	.66**	.66**	-								
18. Mentor1	-.09	-.02	-.04	.07	.38**	.42**	.43**	.38**	.47**	.70**	.71**	.68**	.70**	.72**	.73**	.73**	.64**	-							
19. Mentor2	-.10	-.05	0.00	.11	.34**	.38**	.41**	.37**	.30**	.61**	.77**	.72**	.72**	.65**	.74**	.71**	.68**	.70**	-						
20. CN1	-.06	-.02	-.01	.04	.22**	.40**	.40**	.40**	.32**	.62**	.63**	.61**	.61**	.63**	.71**	.70**	.62**	.66**	.62**	-					
21. CN2	-.11	-.03	-.02	.02	.22**	.39**	.46**	.38**	.33**	.60**	.63*	.61**	.64**	.62**	.68**	.68**	.72**	.63**	.61**	.61**	-				
22.Innovator1	-.10	-.05	-.04	-.05	.20**	.32**	.39**	.49**	.33**	.60**	.69**	.66**	.67**	.67**	.71**	.66**	.63**	.64**	.70**	.61**	.63**	-			
23 Innovator2	-.18*	-.04	-.06	.03	.28**	.44**	.47**	.43**	.39**	.65**	.75**	.65**	.73**	.70**	.74**	.71**	.69**	.71**	.76**	.68**	.75**	.71**	-		
24. Monitor1	-.10	-.07	.01	.03	.27**	.39**	.41**	.44**	.32**	.67**	.68**	.67**	.70**	.69**	.73**	.74**	.67**	.65**	.73**	.74**	.71**	.67**	.74**		
25. Monitor2	-.08	0.00	-.10	.03	.31**	.35**	.43**	.42**	.34**	.58**	.62**	.59**	.58**	.58**	.71**	.63**	.69**	.64**	.62**	.60**	.64**	.63**	.66**	.65**	-
M†	*.23*	*4.14*	*13.41*	*2.54*	*1.95*	*3.20*	*3.41*	*3.14*	*3.27*	*3.69*	*3.80*	*3.75*	*3.78*	*3.76*	*3.81*	*3.84*	*3.96*	*3.68*	*3.71*	*3.90*	*3.98*	*3.91*	*3.80*	*3.81*	*3.91*
SD††	*.27*	*1.86*	*6.27*	*.98*	*1.02*	*.61*	*.61*	*.62*	*.61*	*.96*	*.93*	*.98*	*1.00*	*.89*	*.90*	*.95*	*.82*	*.95*	*1.04*	*.93*	*.92*	*.92*	*.93*	*.96*	*.85*

Note. * $p < .05$, ** $p < .001$
GD: Global dispersion; FT: Facilitator; CN: Coordinator
M†: Mean; SD††: Standard Deviation

Measures

Participants responded to the Team Information Form, which included overall team input variables: global dispersion of team members (Blau, 1977), and number of team training sessions (Warkentin & Beranek, 1999), team process variables: team leader role effectiveness (Denison et al., 1995), and team output variables: team performance (Hinds & Mortensen, 2005).

First of all, Blau's (1977) heterogeneity index formula was used to measure the degree of team members' dispersion across countries (global dispersion). It was calculated by summing percentages of people living and working in a certain nation:

$$1 - \Sigma_i^n p_i^2.$$

Where p_i represents the percentage of i^{th} group residing in the same nation among team members. If all team members reside in the same country, the index would be zero; conversely, 1 represents that all team members live in different countries. Therefore, the heterogeneity index ranged from 0 to 1.

Team members' locations, team size, and team tenure were controlled in the model. Team members' locations (geographic diversity) were measured in terms of geographic locations where members work (O'Leary & Cummings, 2002). The site variable indicated how many sites a team occupied. The size variables referred to the number of team members. The tenure item indicated longevity of each team (Beckman, 2006). Lastly, the training variable was measured based on the number of training sessions (i.e., how much teambuilding or team skill development has taken place?).

The team process was measured by a questionnaire on leadership role effectiveness. The following eight leadership roles were considered as a factor of team leader role effectiveness: innovator, broker, producer, director, coordinator, monitor, facilitator, and mentor. There were two items asking about their leader's role effectiveness for each role, a total of 16 items (α = .971) used for measuring the leadership role factor. We adapted Denison's framework based on the VT context of our study. All individual variables were measured on a 5-point Likert scale (1 = *poor* to 5 = *outstanding*).

The team performance factor was measured by four items representing the assessment scores about team performance in four categories: *the extent to which the team met its goals, produced high quality work, developed innovative solutions, and operated within its allocated budget* (Hinds & Mortensen, 2005). The four items (α = .786) were measured on a 4-point Likert scale (1 = *strongly disagree*, 4 = *strongly agree*).

Results

The primary purpose of data analysis was to investigate the relationship among team characteristics, leadership role effectiveness, and team performance. Before testing the structural relationship among variables, an exploratory factor analysis (EFA) was conducted to understand leadership role effectiveness. A theoretical model with structural equation modeling (SEM) was examined later to see the overall relationships among factors. All hypotheses were examined by testing both a direct effect from each covariate to team performance and mediation effects of the covariates through leadership role effectiveness. M*plus* 8.2 (Muthén & Muthén, 1998-2017) was used for all analyses.

Exploratory Factor Analysis

Based on Quinn's (1988) model with 20 items representing leadership roles, Denison et al. (1995) found eight factors using data from face-to-face teams. Studies using factor analysis since that time have shown a number of leadership role factors, ranging from two to eight, with VT studies tending to show fewer roles relating to performance. For example, Kayworth and Leidner (2002) found eight types of leadership roles but only one role predicted effectiveness, while Carte, Chidambaram, and Becker (2006) found only two roles predicted performance. Likewise, the current study expected a small number of factors because overall correlations among the leadership role related items were considered high, as shown in Table 1 (min: .57; max: .77). Therefore, eight separate roles might not be necessary in this virtual team study. To check the number of leadership role factors, an EFA was conducted.

Eight leadership roles were not supported by the EFA; instead, a single factor construct was considered for subsequent data analyses. A scree-plot shows a sharp drop-off of eigenvalues after a single factor, which means more than one factor is not necessary (Raykov & Marcoulides, 2011). The following SEM analysis used the single factor construct for leadership role effectiveness.

Structural Equation Modeling

Although item responses were from individuals (i.e., team members), the data presents a cluster characteristic; individual responses are more correlated with people in the same cluster (i.e., teams) than with responses in the other cluster. If analyses ignore such a dependency within the cluster, results may be biased (Hox, 2002). While attempting to adjust the dependency, we followed the design-based approach (Muthén & Satorra, 1995), which is to adjust underestimated standard errors of parameters from the dependency to control inflated Type I errors without multi-level modeling (Muthén & Satorra, 1995; Wu & Kwok, 2012). If models for individual-level and cluster-level are the same (Wu & Kwok, 2012), or a number of clusters and cluster sizes are small (e.g., less than 50 clusters and smaller than 10 cluster size), the design-based approach is preferred (Muthén & Satorra, 1995). As the team size and number of team members in our data were considered small, and because our theoretical model was not separated into the two-level model, we used the design-based approach by using the M*plus* default analysis setting (i.e., TYPE = COMPLEX).

A confirmatory factor analysis (CFA) model with covariates (MIMIC) was tested to verify the measurement model. A single team performance factor measured by 4 indicators and a single-factor leadership role effectiveness via 16 indicators mainly compose the MIMIC model. Two covariates (i.e., global dispersion, and team training), and three control variables (i.e., site, size, and team tenure, size, and site), with a single item respectively, have paths on the team performance and leadership role effectiveness factors. The fit indices for the CFA model are reported in Table 2. Since the $\chi 2$ (Chi-square) fit index is affected by the sample size and falsely rejects the model with a large sample size, alternative fit indices were interpreted. The tested CFA model was considered to have acceptable fit indices (CFI = .946, RMSEA = .056, and SRMR = .042) based on Hu and Bentler's (1999) recommendation (CFI is > .95, RMSEA < .06, and SRMR < .06)

A model in Figure 2 was used to test hypothetical relationships. The model is a structural model showing both mediation effects (indirect effects) and directs effects on team performance. Global dispersion and team training have indirect paths on team performance through leadership role effectiveness as well as they have direct effects on two endogenous factors. Site, size and team tenure are controlled by having paths on team performance. Global fit indices in Table 2 supported this model. Two hypothesized mediation effects were supported. The global dispersion and training effects were significantly mediated through leadership role effectiveness. In Figure 2, two dotted lines from global dispersion and team training indicate mediation effects on team performance through leadership role effectiveness.

Table 2

Global Model Fit Indices of Analyses

MODEL	$\chi^2_{(df)}$	**CFI**	**RMSEA**	**SRMR**
EFA for leadership role effectiveness	$299.276_{(104)}$ **	.954	.080	.027
MIMIC (CFA)	$461.303_{(259)}$ **	.946	.056	.043
Structural Model	$474.991_{(272)}$ **	.952	.050	.048

N = 294, *p < .05, **p < .01

The standardized estimates for each hypothesis are shown in Table 3. Hypothesis 1 is represented by paths from global dispersion. Only H1b was supported, which means the effect of global dispersion was fully mediated through leadership role effectiveness. Because of a negative direct effect of global dispersion on leadership role effectiveness (γ = -.150) and a positive direct effect of leadership role effectiveness on team performance (β = .680), global dispersion has a negative mediation effect on team performance ($\gamma\beta$ = -.102). Therefore, more diversely dispersed VT

members shows lower team performance because leadership role effectiveness negatively mediate this relationship. In other words, smaller global dispersion indirectly shows positive effects on team performance after controlling leadership role effectiveness.

Similar to global dispersion, team training's direct path on team performance was not significant (not supporting H2a), but its mediated effect was significant (supporting H2b). As the training effect on leadership role effectiveness is positive ($\gamma = .341$), leadership role effectiveness fully mediated the positive relationship between team training and team performance ($\gamma\beta = .232$). Higher team performance is expected with an increased number of eam training sessions after controlling leadership role effectiveness.

In addition to that, the study found that site size had negative direct effects on team performance ($\gamma = -.280$ and $\gamma = -.182$). This indicates that better team performances are expected with smaller number of sites in a team and smaller team size. However, team tenure had no effect on team performance.

Table 3

Test of Hypothesized Direct and Indirect Effects (Mediation Effects) of Covariates

Path: To Team Performance	**Direct effect**			**Indirect effect:** Mediation effect by Leadership Role		
	Ha	**Estimate (*s.e.*)**	***p***	**Hb**	**Estimate (*s.e.*)**	***p***
H1: Global Dispersion	H1a, not supported	.105 (.058)	.071	H1b, supported	-.102* (.049)	.039
H2: Team Training	H2a, not supported	-.084 (.065)	.193	H2b, supported	.232** (.049)	.000

$N = 294$, $*p < .05$, $**p < .01$

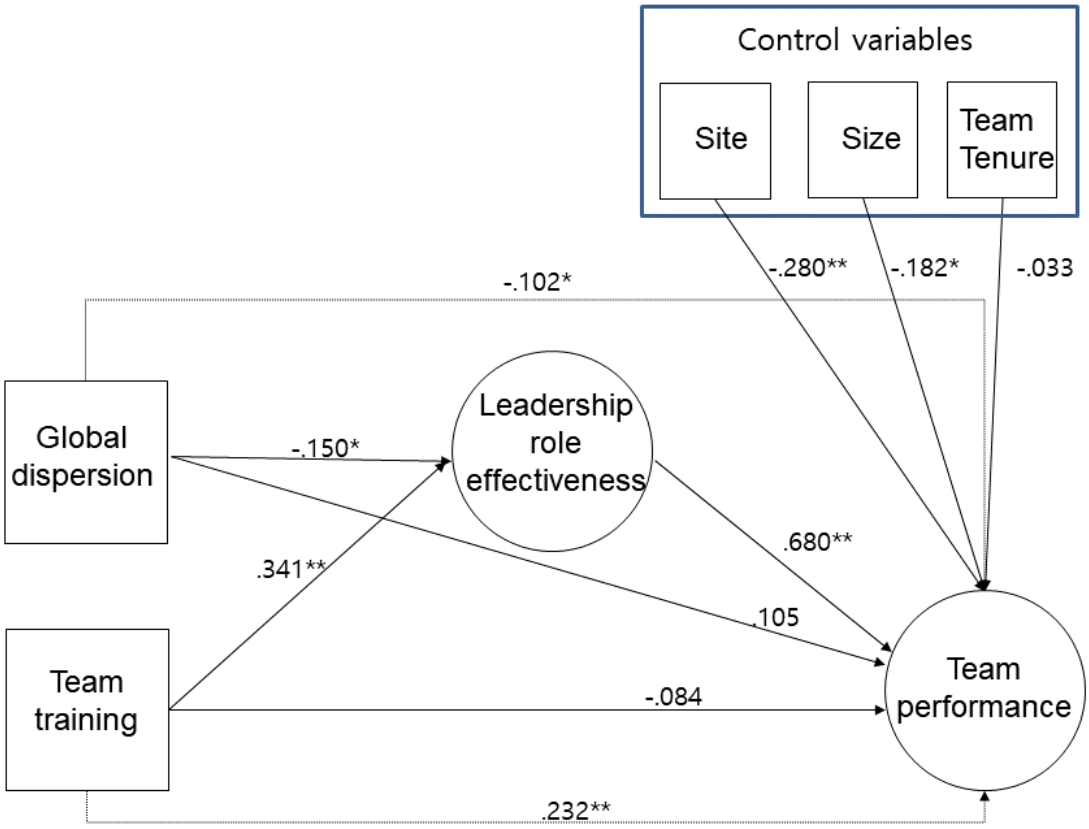

Figure 2. Illustrative path diagram of the model with standardized coefficients Note: Straight lines indicate a direct path, and dotted lines indicate an indirect path *$p < .05$, **$p < .01$

Discussion

This study has found that leadership role effectiveness mediates some relationships between team input characteristics and team performance. Leadership role effectiveness fully mediated the relationship between global dispersion/the number of team training sessions and perceived team performance. Based on our finding, better team performance is predicted with less geographically dispersed VT members and more training sessions due to leadership role effectiveness mediates their effects. We have controlled site, size, and team tenure, and found that the number of work sites and team size had negative effects on VT performance, but team tenure had no significant effect on performance.

Several results in our analysis of the data were surprising. First, an EFA of the 16 leadership role items resulted in a single-factor with loadings of items ranging from .756 to .871. According to the correlation matrix in this study, the 16 items are highly intercorrelated. A review of prior studies using the leadership roles originally proposed by Quinn (1988) and first tested by Denison et al. (1995) shows that only one study had a correlation matrix with similarly high coefficients (See Table 4). Correlation matrices in prior studies were based on ratings from Self, Direct Reports, Peers, or Immediate Supervisors. As shown in Table 4, the lowest range of correlations was in the Self-rating matrix and the highest range of correlations was in the Direct Report matrix, which most closely resembles the correlations in our sample from virtual project teams. This may imply that rating items on the Quinn scale shows the finest differentiation of behaviors when the rater is more familiar with the subjects and the least fine differentiation across roles when familiarity is at its lowest, such as with direct reports whose status difference or geographical distance creates psychological distance and a barrier to familiarity.

Some of the empirical studies using the Denison et al. (1995) instrument used EFA. Few of those reported detailed results. From the information in Table 4, we can surmise that different factor structures emerge from different kinds of samples. Other scholars have reported similar changes in factor structure across samples (e.g., Cho, et al., 1999; Jones, Back, & Beck, 2002; Lucente, Fals-Stewart, Richards & Goscha, 2001; Newton, Connelly, & Landsverk, 2001; Swan, Gambone, Van Horn, Snow, & Sullivan, 2012). This has been referred to as a context effect (Glendon, Clarke, & McKenna, 2016, p. 366). Such variation across samples raises a question about generalizability of the instrument and, therefore, the model or theory it represents. Replication becomes essential for establishing rigorous support of new models to demonstrate that findings are not context specific. The studies profiled in Table 4 show five VT samples; however, only one besides ours uses employees instead of students and that study relies on questionnaires from team members at a single location. Replication of our type of sample will be essential in testing the factor structure for virtual teams working across boundaries.

Table 4

Comparison of Leadership Roles from Prior Studies

Question set	Number of Items*	Type of Analysis	Factors	Subjects	Work Setting	Countries	Range of Correlations	Range of Scale Reliabilities
Han, et al. 2017, current paper	16	EFA	1	Team leaders rated by members	VT	Multiple	.58 - .77	.97
Kayworth & Leidner, 2002	20	MANOVA	8 - only 1 predicted effectiveness	Students	VT	3 - France, Mexico, & USA	NA	.60 - .93
Denison, Hooijberg, & Quinn, 1995	20	MDS	8 forced	Managers	EFT	1 - USA	NA	.61 - .87
Hooijberg & Choi, 2001	20	CFA with SEM	6	Managers - manufacturing & government	FTF	1 - USA	NA	.69 - .95
Hooijberg & Lane, 2005	20	CFA with SEM	6	4 types of raters - upper level managers	FTF	1 - USA	.09 - .74	NA
Lin & McDonough, 2011	6	PC - Equimax	2	Managers	FTF	1 - Taiwan	NA	.89 - .90
Govender, & Parumasur, 2010	40	PC - Varimax	8	Managers	FTF	1 - South Africa	.32 - .60	NA
Vilkinas & Cartan 2001	16		focus on Innovator	Managers	FTF	1 - Australia	NA	.66 - .91
Jawadi, Daassi, Favier, & Kalika 2011	16	EFA - type & rotation not listed	4 assumed in 4 categories	Managers	VT	Multiple	NA	NA
Strang, 2007	30	Qualitative & ANOVA	4	6 project leaders	FTF	1 - USA	NA	NA
Carte, Chidambaram, & Becker, 2006	8	Qualitative	8 roles - 2 stood out: Producer and Monitor	Student teams	VT	1 - USA	NA	NA
Plotnick, Hiltz, Ocker, & Rosson 2008	22	Regression	NA	Students	VT	2 - USA & Netherlands	NA	.88 - .94

*NOTE: Some or all of the 20 items that Quinn (1988) developed in his book to assess managers eight leadership roles of the Competing Values Framework were used in all these studies.
**NOTE: NA means the data was not available in the publication.

Based on our findings, leadership can be critical when facilitating performance of geographically dispersed VTs. In our study, the geographical dispersion of VT members was not directly related to the team performance, but its relationship was meaningful when the leadership role intervenes their relationship. The more geographically dispersed VT members have shown lower team performance because the level of dispersion and leadership role effectiveness was negatively related. Previous studies have shown that certain aspects of leadership may have a pivotal role in influencing important team outcomes in geographically dispersed settings (Joshi, Lazarova, & Liao, 2009), and it was supported by this study.

Our findings also support that leadership fully mediates the relationship between the number of VT trainings and team performance. As team members study how to build an effective team by learning team skill sets, team training may improve team performance. In a previous study of virtual teams, training in conflict management was found to be useful (Martínez-Moreno et al., 2015). Aligning with the empirical support, this study found that team training apparently impacts perceptions of performance indirectly through perceptions of leadership roles.

Even though we did not set hypotheses on relationships between control variables and team performance, we found one unexpected result. Compared with previous studies (Beckman, 2006; Sine et al., 2006), team tenure did not have a significant effect on leadership role effectiveness or team performance. However, a larger number of member sites and the size of teams had negative effects on team performance. We need to acknowledge that different team settings may result in different outcomes. Our findings suggest that managers may want to plan to minimize the size of a team and a degree of dispersion to create better conditions for teams to be effective together.

Limitations

The surprising results of our study warrant further investigation, though some limitations may need to be addressed in follow-up research. First, our assessment of training, leadership role effectiveness, and team performance was based on respondents' perceptions rather than using objective measurements. Method bias may occur as we used team members as a single source (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003), excluding team leaders. Secondly, we did not control other possible variables (e.g., individual expertise, gender, age, task complexity, etc.). Third, as different organizations have different sets of VT training practices, the generalizability of our findings is somewhat limited.

Practical Implications and Future Research

The nationally diverse VTs may require more attention for management and a different skill set to deal with cultural complexities (Han & Beyerlein, 2016; Han, Jeong, & Beyerlein, 2017; Liao, 2017). Therefore, we suggest the following practical implications and future research suggestions for practitioners and researchers who are preparing to manage VTs. This study illustrates the importance of team training. Organizations can develop training modules and policies for VT leaders and members. In one study, over 60% of respondents report that their organizations provided no specific VT training, even though employees realize the need for training modules (Rosen et al., 2006). Specifically, our findings propose that effective leadership is an important means of achieving higher VT performance, maybe because the leadership roles of social facilitation and communication processes can be more important as compared to traditional teams (Kayworth & Leidner, 2002; Kirkman, Rosen, Gibson, Tesluk, & McPherson, 2002).

As we used a face-to-face leadership role effectiveness construct in this study, further research should be conducted to examine if there are other types of leadership roles that are needed for virtual teams (Lester & Kezar, 2017). Also, VT leadership roles may be less recognized or identified by VT members due to perceived isolation (Connaughton & Daly, 2004). Therefore, VT leaders may need to be trained and encouraged to create a more visible presence for their remote teammates to compensate for lack of face-to-face contact.

The competing values framework (Quinn, 1988) continues to be used in research studies to provide a theoretical perspective for scholars for over a quarter century since its publication. However, the frequency, variety, and rigor of studies in the past few years seem to require more attention. An issue that our study raised can facilitate future work to explore whether eight roles are required to describe leadership behaviors in a wide range of settings. The findings by Kayworth and Leidner (2002), Kahai et al. (2003), and Carte et al. (2006) suggest that only a few roles are significant in generating team effectiveness, so future researchers need to examine whether the reduced leadership

role set is a consequence of specific team settings, such as the virtual, or represents a refinement in the framework that involves tailoring the leadership role model to specific contexts. Further testing with VTs can aid in confirming or disconfirming the pattern we found.

Conclusion

Global virtual teams have become an essential way of organizing knowledgeable workers across the globe. We tested Behavioral Complexity in Leadership Theory (Quinn, 1988) in the virtual team context, and although it seems reasonable to assume that applying multiple leadership roles may increase team performance in globally distributed teams, our results did not show that members perceived that variety. Rather, EFA resulted in the eight roles from Quinn's (1988) and Denison et al.'s (1995) work collapsing into a single role factor. No other published studies could be found with a similar sample to determine whether our findings applied to new product development VTs across samples. This issue requires more study because Behavioral Complexity in Leadership Theory suggested that the perceived variety of team leader roles relates to performance. Lastly, training of team members or leaders in terms of skill/team development may be crucial in elevating leadership and team performance from mediocre to exceptional.

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